

## Appendix A

### DIVER INSPECTION OF STRUCTURES

#### INTRODUCTION

This appendix is a brief summary of procedures for locating and assessing damage to underwater structures.

Underwater inspection requires the use of diving equipment. Hardhat diving equipment provides good stability in flowing water and good protection from a dangerous bottom, moving debris, and/or sharp fouling organisms, but affords less freedom of movement. Scuba equipment does not provide such protective clothing, but permits faster inspection because of greater mobility. A hardhat diver should remain in constant contact via a two-way telephone with an assistant topside who relays instructions and data between the inspector and the diver and provides necessary diver support. A scuba diver usually surfaces to communicate findings to the inspector or engineer; however, communication by radio telephone is preferable. Closed-circuit underwater television equipment (especially with facilities for tape recording) can be of great value. Underwater photography may also be useful for documentation.

All fouling organisms, rust, and other surface contaminants must be removed before a close-up inspection of underwater surfaces can be made. This is usually done at spot locations rather than cleaning an

entire structure. The preference for a raft or boat for handling diver and inspection equipment (if both are available) depends upon the calmness of the waters and the need for mobility, as well as other job requirements.

An engineer and activity representative should be present whenever underwater inspections are made. They are necessary to explain to the diver exactly what should be found, i.e., number and size of piles, type and depth of bulkheads, location of tiebacks, cross bracing, etc. The engineer shall evaluate the diver's observations, determine the degree-of-hazard, and recommend repairs.

The following general diver equipment is necessary:

- Portable flashlight
- Special sampling equipment (see Table A-1)
- Writing slate
- Air-powered scrapers or wire brushes for removal of fouling, rust, silt, etc.
- Easy-to-read measuring tape
- Wrecking bar
- Probe, such as sharp ice pick
- Knife, hand scraper, and hammer
- Sounding gear for determining depth and other measuring devices

The activity shall provide as-built drawings previous inspection reports, or other information that will assist the diver and engineer in locating critical areas or areas at which damage had previously been noted.

Table A-1 identifies special inspection equipment, visual observations, and measurements, ratings, or samplings required for inspecting structures made of different construction materials.

Table A-1. Inspection of Specific Structures

Construction  Material	Special Sampling Equipment	Visual Observations	Measurements, Ratings,  or Samplings
Wooden	Calipers for determining piling diameter Sonic equipment for detecting hollow areas in piling Increment borer for determining quality of preservative or soundness of piling Treated wooden plugs for holes left after boring	Breaking or cracking from impact or overload Detection of <i>Limnoria</i> or teredine siphons on surface Areas of reduction of piling diameter from abrasion or marine borer attack Areas of riddled or lost wood Condition of pile barriers Diameter/condition of fasteners (bolts, etc.), cables, wraps	Piling diameter Location and size of damaged areas Depth of cracks and other damaged areas Rating of piling condition Data from sonic equipment Wood samples or increment borings
Concrete	Hammer Chipping tool Concrete-core rotary drilling equipment Sonic or ultrasonic equipment for detecting voids Power source	Chipping, cracking, spalling, and disintegration Rust spots Condition of exposed steel Joint conditions Bottom scouring, undermining	Location and size of damaged areas Depth of chips, cracks, spalls, etc. Drilled concrete cores Sonic or ultrasonic data
Stone masonry <sup>b</sup>		Chipping, cracking, abrasion damage Settlement and horizontal displacement Erosion of soil through joints or cracks	Location and size of damaged areas Depths of chipped, cracked, or abraded areas
Rubble-mound		Erosion of core material by wave action Erosion of small stones in riprap Stability of armor stones or blocks Breakage and displacement of concrete armor elements Washing out of substrate at the toe of structures	Location and size of damaged areas Slope of structure

continued

Table A-1. Continued.

Construction  Material	Special Sampling Equipment	Visual Observations	Measurements, Ratings,  or Samplings
Rubble-mound (con't)		Undermining of foundation High water mark; overtopping Settling of structures	
Structures involving soil		Erosion of foundation or slopes Subsidence of soil because of lost backfill through cracks or holes in bulkheads, etc.	Location and size of damaged areas
Steel	Scale or calipers for determining thickness Ultrasonic equipment for determining thickness Equipment for measuring electric potentials on cathodically protected steel Pit gage Equipment for patching holes cut into steel structures by impact Power source	Coating condition (peeling, blistering, erosion, etc.) Condition of cathodic pro- tection equipment (broken or corroded conduits, loose wires, lost anodes, etc.) Extent of corrosion Type of corrosion (density, pitting, etc.) Members structurally damaged potentials  Open seams or holes in quay- walls, etc Soil subsidence because of lost backfill through seams or holes Inspection of welds	Metal thickness Location and size of damaged areas Depth of pits and extent of their occurrence Samples of corrosion products or damaged coatings Cathodic protection  Deformation of structural members

<sup>a</sup>The diver notes the diameter loss (which is later classified as shown in Figure A-1), whether damage is general or localized at a particular depth, and unusual conditions prevailing.

<sup>b</sup>Interiors of graving docks are ordinarily inspected at a time when the docks are empty. Divers are required to inspect aprons or entrance settlement and condition of approaches.

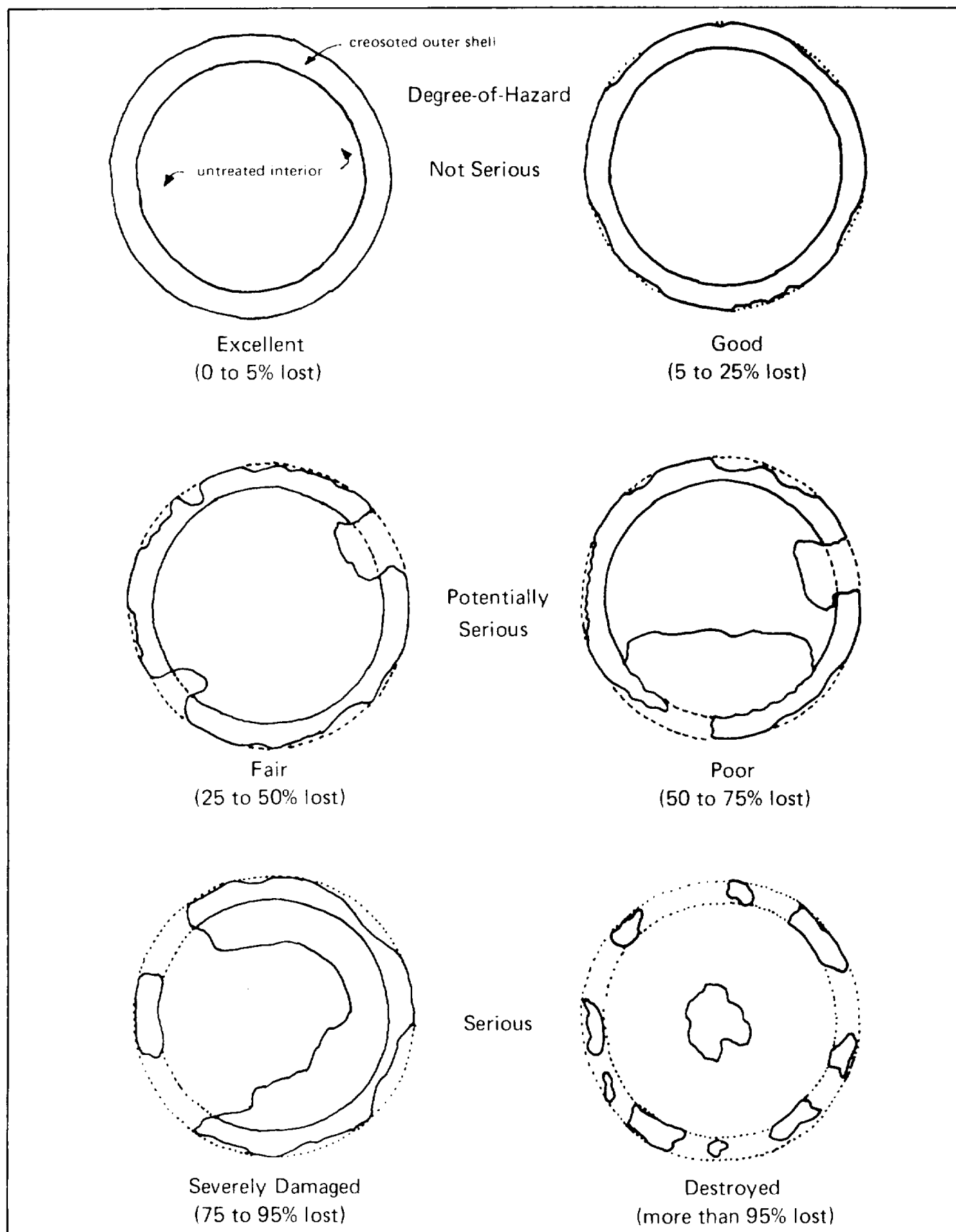


Figure A-1. Cross section of piles with different damage ratings.